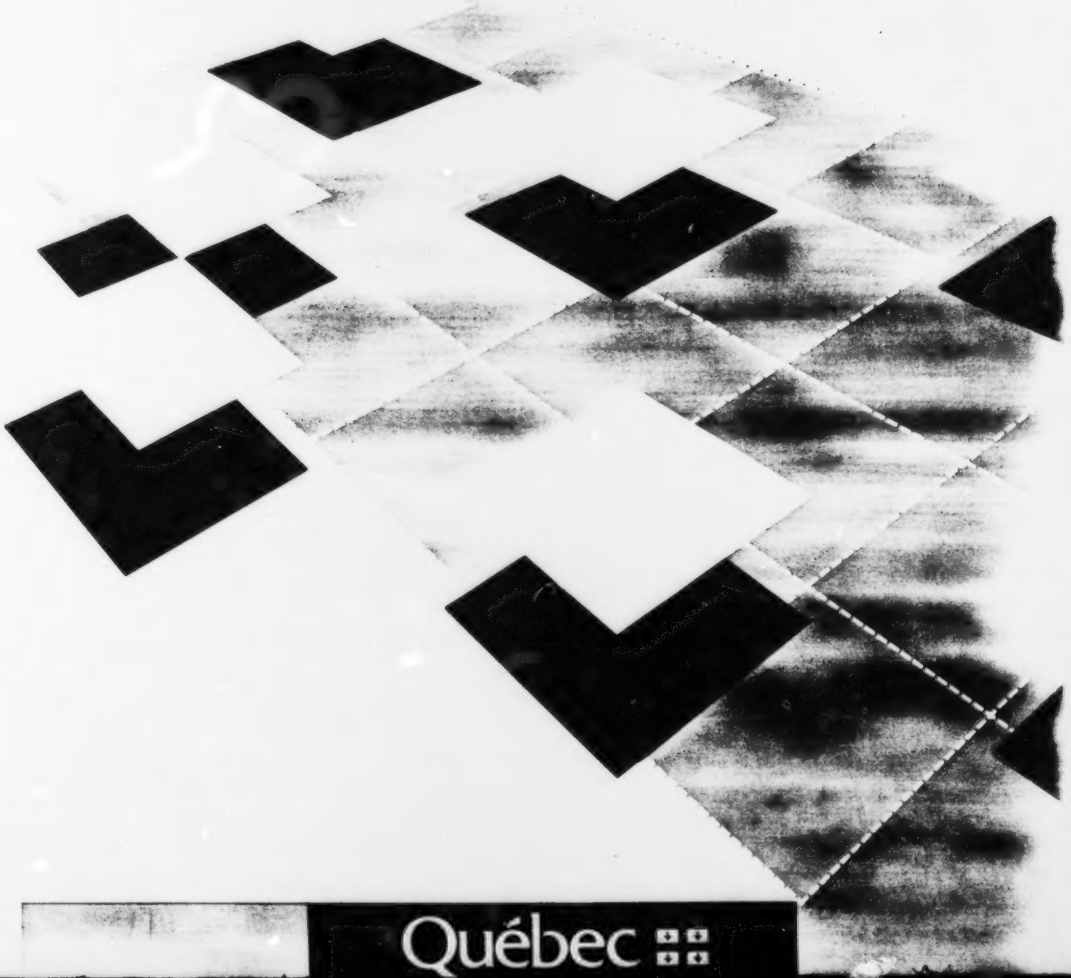
LA SOCIÉTÉ D'HABITATION DU QUÉBEC

Technological Innovation in Residential Construction and Production of Housing Using Non-Traditional Methods



Québec

Technological Innovation in Residential Construction and Production of Housing Using Non-Traditional Methods

Société d'habitation du Québec
Direction de l'analyse et de la recherche
André Poitras, Engineer
Jocelyn Duff, Architect
December 1988

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INTRODUCTION

Construction is viewed as a reflection of a country's activities and economic, social and cultural values. It is an integral part of the economy and its influence extends to almost every sector of an expanding economy.

Residential construction is the largest economic sector and the industry has always adapted itself to changes in this market. However, the outlook for new household formation indicates a continuing decline in demand for new housing, which will unsettle the construction industry.

This document deals with technological changes in the housing sector in Québec and elsewhere. It also provides an overview of the construction industry in Québec and the real threats posed by foreign competition and the small degree of concerted action in research and development in the residential construction sector.

In an increasingly competitive economy, the construction industry, like all others, will have to become more open to technological changes if it wishes to remain competitive and flourishing.

We wish to thank Mr. Claude Frigon, Mr. François Renaud, Mr. Bertrand Roy and Mr. Jacques Trudel for their astute comments on the text. We would also like to express our appreciation to Mrs. Huguette Tellier for her tireless word-processing efforts.

1 THE SOCIAL AND ECONOMIC CONTEXT

1.1 The economic importance of residential construction in Québec

1.1.1 Spending and investment

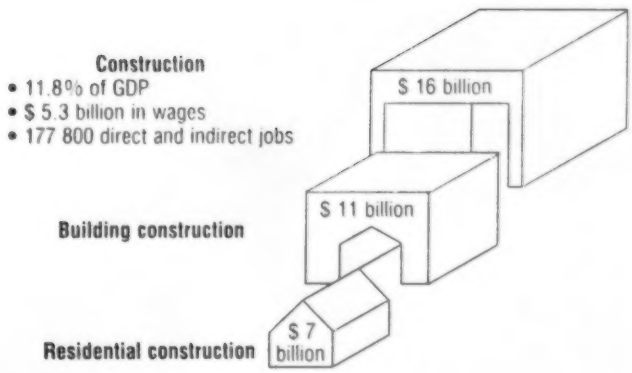
In 1987, construction work in Québec, including buildings and engineering works, amounted to more than $16 billion and, according to the latest Statistics Canada Provincial Economic Accounts, accounted for 11.8% of Québec's gross domestic product.[1-2]

Building construction alone accounted for more than $11 billion of which $7 billion or 64% of all building activity is attributable to residential construction.

Private and public investment in fixed capital, machinery and equipment in the housing sector in 1987 was estimated at $8.5 billion and generated additional investment of $849 million in upkeep. This accounts for more than 30% of all capital investment in Québec.[3]

It is easy to see that the residential construction industry is an essential part of our economy and that it makes a substantial contribution to the achievement of social and economic objectives.

Figure 1
Economic Importance of Residential Construction in Québec, 1987



1- Statistics Canada. **Construction in Canada**, catalogue no. 64-201, annual.
2- Statistics Canada. **Provincial economic accounts**, catalogue no. 13-213, annual.
3- Statistics Canada. **Private and public investment in Canada**, catalogue no. 61-205.

1.1.2 Impact on other sectors of the economy

Expenditures in the construction industry have an impact in every sector of the economy. They generate purchases of raw materials, semi-finished goods, equipment, transportation costs, spending for services and construction of infrastructures.

In Canada, it is estimated that one dollar spent on construction generates another $1.83 of spending in all activity sectors. This is high when compared to agriculture, which generates $1.72 for every dollar spent, transportation ($1.70), and business services ($1.56).[4]

Labour accounts for about one third of construction costs.[5] In 1987, the industry's payroll in Québec amounted to $5.3 billion, of which a substantial portion was reinvested in a wide variety of sectors.[6]

1.1.3 Employment

The construction industry in Québec employs 124 000 people directly, of whom 103 900 work in building construction.[7]

The 177 800 direct and indirect jobs which depend on construction account for almost 5% of the total labour force.4 Nonetheless, this is below the rate in many industrialized countries: 11% in Japan, Italy and the Netherlands, 7% in France and Great Britain.[8]

Construction jobs are well paid. In August 1987, the average weekly pay of a construction worker in Québec was $737.25, compared to $391.39 for the average wage-earner.[9]

The economic activity generated by residential construction benefits every region, since the resulting employment is distributed throughout the province. A major shift in the level of activity in this sector would therefore inevitably have an impact on Québec's economic and social structure.

1.2 Expected slowdown in residential construction in Québec

1.2.1 New household formation

The arrival of new households on the housing market has a major influence on residential construction activity.

The high number of starts during the last few years was expected, since the market simply reflected the effects of the peak of the demographic curve reached in 1957.[10] In fact, individuals generally reach 30 years of age before they form households and enter the housing market as potential homeowners or tenants and have a direct influence on the level of demand. Forecasts for the number of new households over the next few years all agree that we can expect a gradual decline (see Figure 2).

4- Institute for Research in Construction. **The Construction Industry and the Issues Facing It: An Overview**. Ottawa, National Research Council of Canada, 1986. pp.13-14.
5- Institute for Research in Construction. Op. cit., p. 13.
6- Statistics Canada. **Employment, earnings and hours**, catalogue no. 72-002.
7- Statistics Canada. **Construction in Canada**, catalogue no. 64-201, annual.
8- Office of Technology Assessment. **Technology, Trade and the U.S. Residential Construction Industry**. Washington, D.C., Congress of the United States, 1986. p.32.
9- Statistics Canada. **Employment, earnings and hours**, catalogue no. 72-002.
10- Achour, Dominique. «Après le babyboom, la décroissance», **Municipalité**, September 1987, p. 7-9.

The demographic forecasts of the Bureau de la statistique du Québec (BSQ) indicate that between 1981 and 2001, the number of households between age 25 and 34 will drop by 6.8%. The forecast average of 45 800 new households per year up to 1991 is expected to fall to 38 400 for the period 1991-1996, and finally to 36 000 by the end of the century.[11]

Georges Mathews, an economist, is much more pessimistic. He indicates that the average of 39 400 new households per year between 1986 and 1991 could fall to 29 400 beginning in 1991-1996.[12]

1.2.2 Forecasts of housing starts

The positive effects of the demographic explosion of the 1950s on housing starts in Québec peaked in 1987. The main economic forecasts already point to a slowdown in residential construction activity in 1988 and 1989.

Figure 2
New household formation in Québec

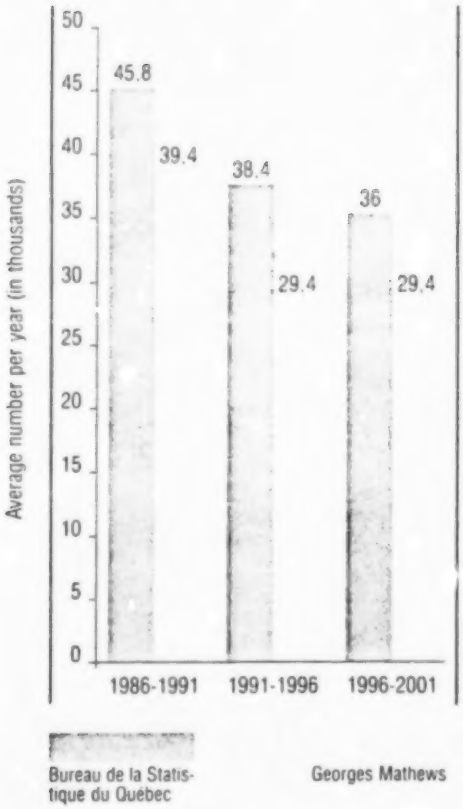
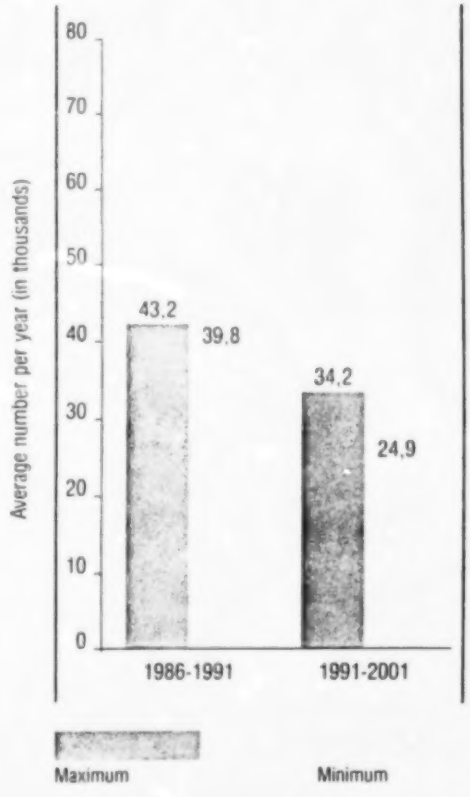


Figure 3
Number of housing starts forecast for Québec



Source: Canada Mortgage and Housing Corporation, 1987.

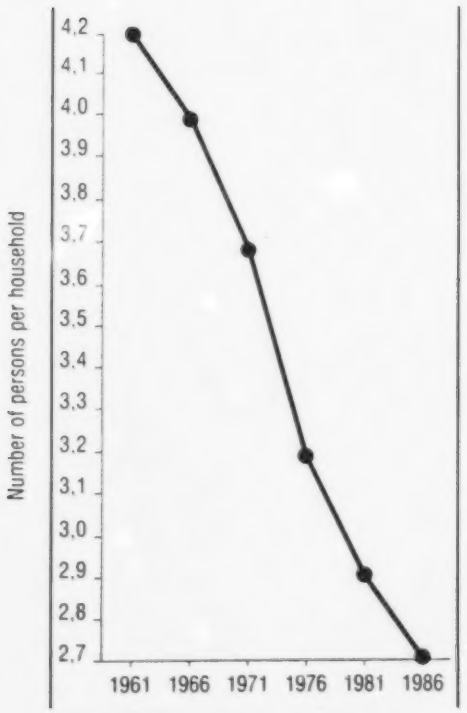
11- Bureau de la statistique du Québec. **Perspectives démographiques infrarégionales**. Québec City, BSQ, 1984.
12- Mathews, Georges. **Le vieillissement de la population : problématique générale et impact sur la marché de l'habitation**, Symposium «Vieillir autonome parmi les siens», January 12, 1988.

A study of long-range projections of new housing needs in Canada done by Canada Mortgage and Housing Corporation indicates that, regardless of migration, the number of housing starts in Québec will decline. From 1986 to 1991, the average annual number of starts will range between 39 800 and 43 200, and between 24 900 and 34 200 from 1991 to 2001 (see Figure 3). Québec will account for no more than from 14% to 19% of total new housing requirements in Canada, compared to 25% between 1981 and 1986.[13]

As demographic growth slows down, the number of new households and, as a result, the number of housing starts, will decline. The fragmentation of existing households and the aging of the population will also have a determining impact on the housing market over the coming decades.

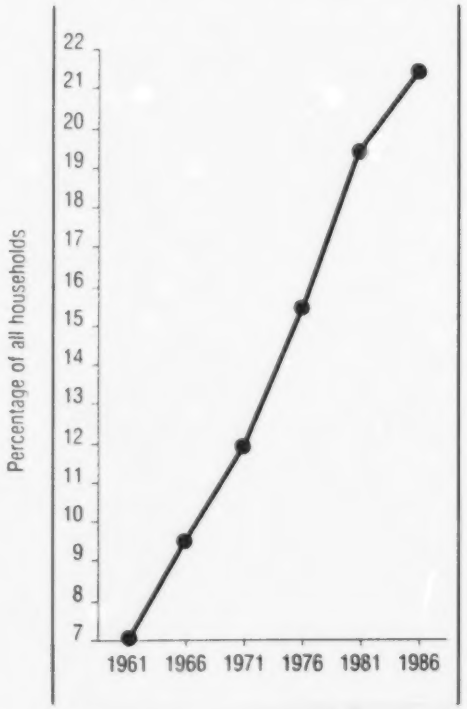
These socio-demographic factors will alter the economic situation which will force residential builders to adapt quickly to the needs of various types of households and improve on traditional methods of housing production in an increasingly competitive market.

Figure 4
Average household size in Québec



Sources: Census of Canada, 1961, 1966, 1971, 1976, 1981, 1986.

Figure 5
Number of individuals living alone in Québec



Sources: Census of Canada, 1961, 1966, 1971, 1976, 1981, 1986.

13- Canada Mortgage and Housing Corporation. **Medium and Long Term Projections of Housing Requirements in Canada**, December 1987.

1.2.3 Fragmentation and household size

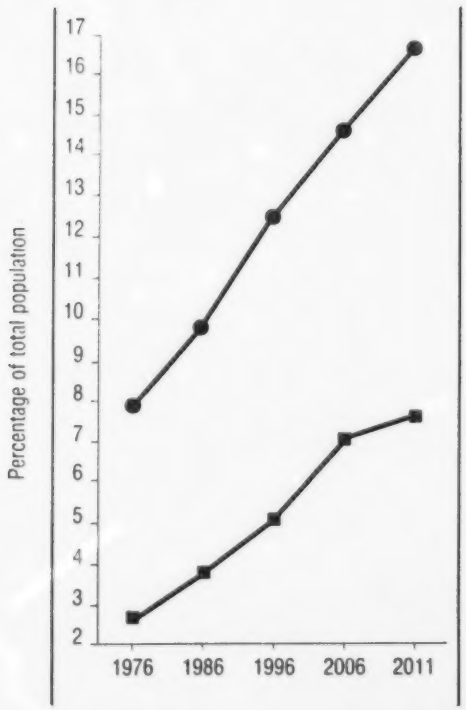
Households are gradually becoming smaller. This is mainly the result of the fragmentation of existing households and the low birth rate.

The average number of persons per household has fallen from 4.2 in 1961 to 3.0 in 1981, then 2.7 in 1986 (see Figure 4). This trend has an impact on the housing market and raises demand for small housing units. In addition, the percentage of individuals living alone has more than doubled (see Figure 5). This means a reduction in building area and adaptation of the market to the needs of an increasingly diversified clientele, consisting not only of people living alone, but also of single parents, couples with or without children, elderly persons, etc.

This trend is expected to continue. The BSQ estimates that the number of persons per household will decline to 2.4 by 2001, a drop of 20% compared to 1981.[14]

The increasing variety of households requires greater efforts from builders. They must meet the needs of clients with varied economic and social conditions and lifestyles.

Figure 6
Number of elderly in Québec



Source: Georges Mathews, 1988.

14- Bureau de la statistique du Québec. Op. cit.

1.2.4 The aging of the population

By the end of the century, the number of individuals 55 or over will have doubled in Québec.[15] During this period, the number of households 65 or over will increase by 73%[16] (see Figure 6).

Since the needs of the elderly can be quite different depending on their degree of mobility and autonomy, the market will have to provide a variety of housing options adapted to the needs of this constantly growing group.

Builders supplying this market will, for instance, have to provide housing units with special equipment (access ramps, support rails, security systems, adapted shelving, etc.) and pay special attention to design details. They will become increasingly involved in the design, development and distribution of new housing alternatives for the elderly.

One such new development is the appearance on the market of housing complexes for retired households and those in early retirement. Many such residences provide cafeteria and hotel services, recreational areas, medical services, organized activities and others. Currently, this market, which appears to be growing, is targeted at high-income clients. However, the elderly from all categories can be expected to demand these new services.

Recent interest in Canada and the United States in the granny flat, a small house set on a relative's lot, is a good example of builders' recent concern in seeking new solutions.

Providing an adequate response to housing demand for the coming decades will be all the more difficult since an appreciable portion of the population will be made up of elderly persons, many of whom are in the low-income category.[17]

1.2.5 The outlook

Undeniably, the slowing rate of new household formation together with the aging of the population, the fragmentation and decrease in the size of households, will contribute to lower housing demand and greater variety of needs.

This phenomenon, which is the result of socio-demographic factors, appears to be long-term in nature unless there is a spectacular upsurge in the birth rate, the effects of which would not be felt for some decades. Demographers also agree that even heavy immigration, will have little impact on the existing situation.[18]

The situation could become worse should mortgage rates or the cost of labour and materials rise suddenly. This would certainly reduce the number of housing starts.

To maintain activity in the housing sector at an acceptable level, builders will have to face this situation and:

— ***DEVELOP NEW DESIGNS AND PRODUCTION METHODS*** **IN ORDER TO REDUCE THE COST OF HOUSING AND SO ATTRACT NEW BUYERS;**

AND

— ***EXPLORE EXTERNAL MARKETS*** **TO OFFSET THE EFFECTS OF LOWER PRODUCTION.**

As international competition grows, other factors contribute to making technological innovation in housing a more attractive option.

15- Achour, Dominique. Op. cit.
16- Bureau de la statistique du Québec. Op. cit.
17- Statistics Canada. **Income distributions by size in Canada**. catalogue no. 13-207, annual.
18- "Les défis démographiques du Québec", conference held by INRS-Urbanisation, Montréal, December 1987.

❷ TECHNOLOGICAL INNOVATION IN RESIDENTIAL CONSTRUCTION IN QUÉBEC

The construction industry enjoyed two years of intense activity in 1986 and 1987, particularly on the residential side, as shown by available statistics. However, this buoyant activity, caused by lower mortgage rates and resurgent demand in the wake of the recession, will fall considerably in the years ahead. Housing starts should drop from over 73 000 in 1987 to less than 50 000 in 1988 and to less than that in 1989, which is more in line with household formation in Québec.

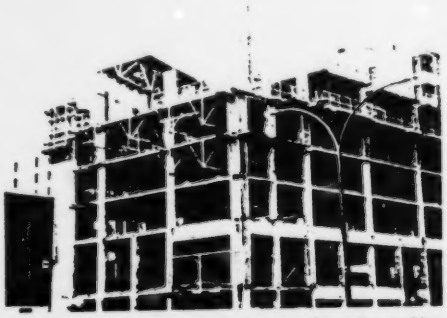
We can now predict that by the year 2000, new housing construction will reach only one third of the level in 1987, unless the industry can establish concerted action mechanisms and take advantage of new markets.

This industry is highly fragmented (80% of companies have fewer than five employees) and subject to seasonal cyclical movements. The future will pose a major challenge to the industry.

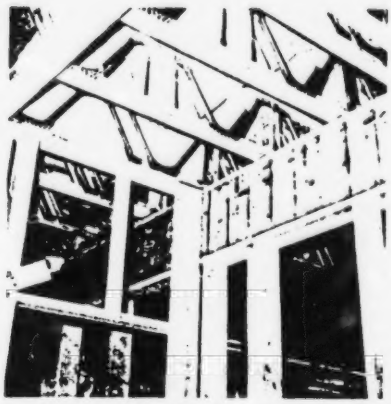
At the present time, the gradual reduction in housing starts can be expected to favour companies with significant capital and large inventories of serviced land. Québec will not be alone in experiencing a construction slowdown, so that competition with neighbouring provinces can be expected to intensify.

Building techniques currently in use perpetuate traditional on-site building methods. New methods and new materials are introduced and accepted but slowly. More often, builders will incorporate any or all of the following: **pre-assembled components** such as roof trusses, pre-framed doors and windows, pre-assembled kitchen cabinets or **new types of materials** that are more economical and easier to assemble, such as chipboard panels, plastic fittings and pipes, aluminum or vinyl exterior siding, urethane insulation materials, etc. However, technological developments only become accepted in Québec once they have been developed and tested elsewhere, particularly in the United States, given the size of that country's market and its resources.

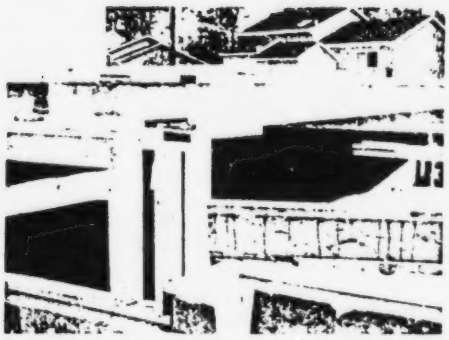
Traditional on-site construction.



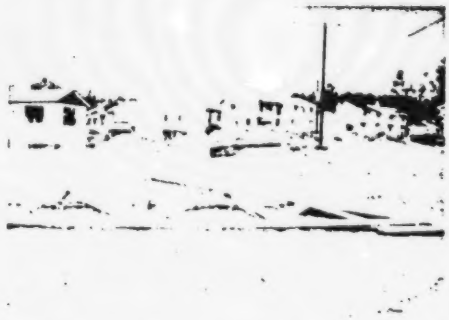
Site industrialization: reusable framing form for making concrete floor slabs.



Site industrialization: perforated beams on joist made of glued laminated



Site industrialization: prefabricated joists using waferboard



Site industrialization: prefabricated roof trusses

Gradually, this dependence on other countries for innovation will weaken the construction industry, as foreign competition grows stronger because of the technological advantage these countries will have built up.

In this context, companies must strive to improve productivity to keep their prices competitive and hold their market share. They must begin immediately to seek new building methods, use new materials and transfer certain technologies to attain more affordable unit production costs. Any delay is to the advantage of the competition outside Québec.

2.1 Earlier technological developments

2.1.1 Heavy prefabrication

In the past, the industry in Québec has tried to reduce production costs by using heavy prefabrication methods.

This was attempted mainly in the construction of concrete apartment towers. The technology used was almost exclusively imported from Europe, where thousands of housing units had to be built after the war. The urgency of the situation led to the development of many new building techniques.

In 1976, the provincial government decided to encourage the development of various prefabrication methods using concrete. It approved the construction of about ten projects of 100 units each for retired persons in various regions of the province. However, the buildings did not incorporate any appreciable cost savings and the experiment was not pursued.

At this time, the Office de la construction du Québec was concerned about the impact of these new building techniques on job losses for skilled labour. These building methods were not developed, judging from the fact that most of the promoters of heavy prefabrication from that time have since left. Today, projects which make use of heavy prefabrication techniques, with complicated connection systems are rare. According to some experts, a large number of units must be produced before these methods can compete with existing techniques.

However, the use of sectional prefabrication techniques is becoming more common, such as concrete «**curtain walls**» and «**aluminum panels**», some of which have insulation already attached at the factory. These innovations are mainly found in the commercial sector and office buildings, since they do not offer an economic advantage for residential construction.

However, research and studies are being done in this area with the participation of plants specializing in concrete, to develop designs which could facilitate overseas exports of projects ready for assembly. **Many countries prefer concrete buildings and research in this area must be continued, in particular to find easier ways of transporting these products.**

2.1.2 Light prefabrication

Light prefabrication covers mainly builders of **modular houses**, also called **sectional houses**, of **mobile homes** installed on lots designed for this purpose, as well as builders of exterior wall **panels**.

This type of residential construction is found particularly in the suburbs. In 1987, it accounted for only 14.7% of the residential market, though its market share had been as high as 25.5% in the 1970s, when demand was especially high in Québec and in other countries[19] (see Figure 7).

More than 4 323 units incorporating these techniques are scattered in suburban regions of urban centres where demand for these houses, generally at an affordable price, is strong.

Statistics collected by the ministère de l'Industrie et du Commerce du Québec (Department of Industry and Trade) show that **exports of houses manufactured in Québec totaled 806 units in 1986**. This accounted for 17% of total output that year and was up by 134% from the 344 units sold outside Québec the previous year. The increase is due to the number of exporting companies growing from 16 to 21, and to the weak Canadian dollar combined with the strong New England housing market.

Manufacturers use the same working and assembly techniques in the plant as on the site, but with more sophisticated tools: multi-blade saws, template assisted framing, conveyors and machines to apply glue or nail rapidly.

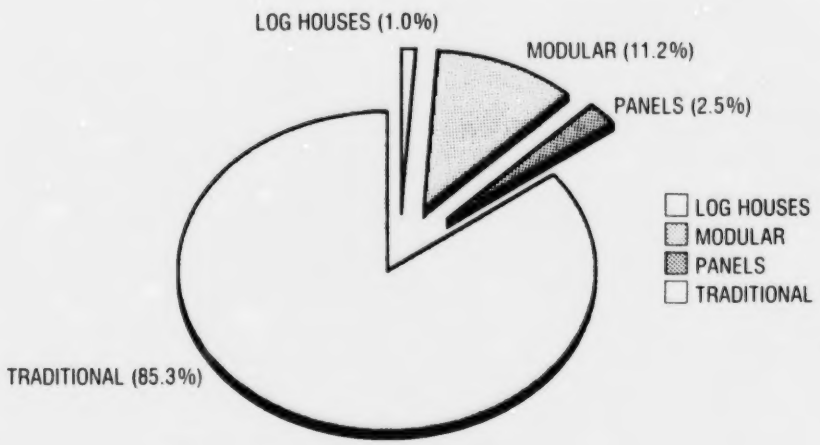
In almost all cases, prefabrication offers savings thanks to standardization, mechanization, the advantages of plant production, improved working conditions sheltered from bad weather and simplified assembly methods in which the need for skilled labour is substantially reduced. Nonetheless, these savings are almost entirely offset by delivery costs and higher fixed costs during the winter months when demand is low.

19- Carrier, Bernard. «La maison usinée poursuit son ascension», **Habitabec**, [Montréal], April 8, 1988, p. 3.

Quality of construction figures prominently in advertising for manufactured housing. Efforts are being made to improve the generally negative public image of these houses.

The complete module design most manufacturers have adopted allows little flexibility from an architectural standpoint, and units look more like low-cost houses built totally on-site.

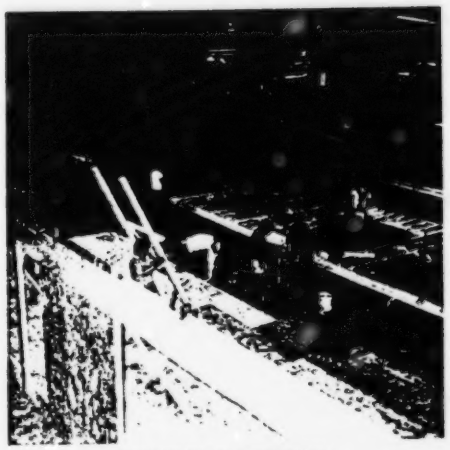
Figure 7
Composition of housing market in Québec in 1987
by construction technology



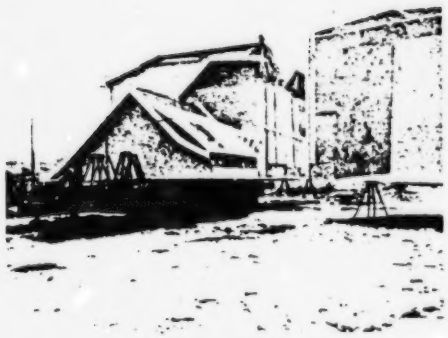
Sources: CMHC, MIC, "Habitabec", April 8, 1988, p. 3.

Builders have some experience in multiple housing on two or three stories, but a significant breakthrough in this market appears unlikely. In addition, on-site building promoters control the best serviced land so that for all practical purposes, the manufactured housing industry is excluded from the urban market, which is growing fastest and is necessary if the industry is to develop.

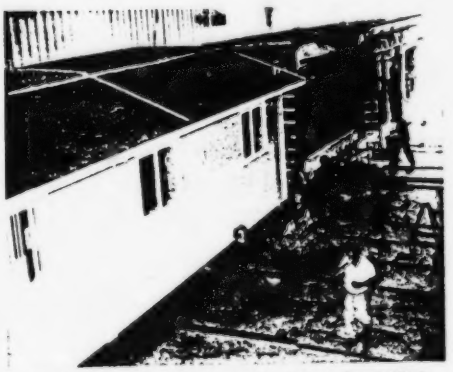
Mobile home site.



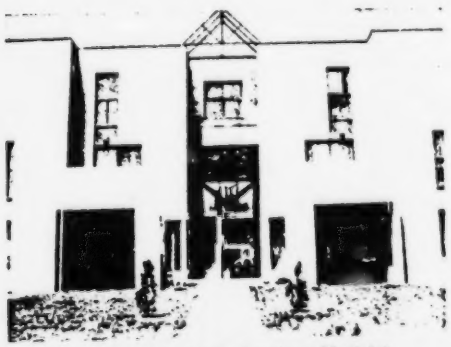
Modular house construction:
making the floor.



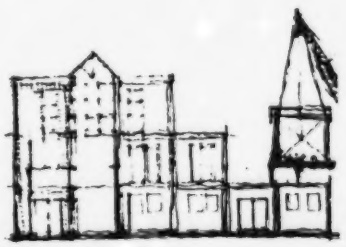
Modular house construction:
final stage before shipping.



Modular houses: house sections with roofing folded
in to reduce shipping volume.



Condominium units in downtown Montréal
incorporating modular construction technology.



Assembling the modules of a multi-unit building.

The Société québécoise des manufacturiers d'habitation (SQMH) (Québec manufacturers housing association), which includes several manufacturers in Québec, intends to promote this sector and in this vein is taking part in an initiative of Canada Mortgage and Housing Corporation (CMHC) featuring the «**granny flat**». This is a small house of about 600 square feet produced in a factory and easily shipped by road. This concept, in which the Société d'habitation du Québec is taking part, would enable parents or grandparents to live on an existing property and thus be close to their family. According to CMHC, this concept could lead to the creation of a market of 60 000 units in Canada by the year 2000, which would give the manufactured housing industry a boost and improve its public image.

Model granny-flat shown at the 1988 Montréal Expo-Habitat.

By being more open to research and development, these companies can improve their methods and achieve greater flexibility to adapt to new needs. They could export more actively and thus reap greater benefits from free trade.

2.2 Recent technological innovations

Manufactured housing offers significant opportunities, as shown by the experience in certain countries such as Sweden and Japan (and to a certain extent in the United States). Sweden and Japan have developed leading technologies in manufactured housing thanks to their research and development efforts (see section 3.2). Government initiatives in these countries have helped speed the development of technological innovations and their implementation in the production of manufactured housing.

Their methods of production make frequent use of computer-assisted design and manufacturing (CAD/CAM) and resemble processes used in the automobile industry. Housing units produced in these countries are of very high quality and their very flexible design allows them to be sold on export markets at affordable prices.

In Québec, traditional building methods still predominate and few innovative designs have been successfully developed or captured a significant share of the market.

According to the Economic Council of Canada, «equipment is the first level to adopt technological innovation, followed by new materials and, finally, new methods.» (translation)[20]

Some of the factors which combine to hamper and even prevent innovation in construction are the fragmentation of the industry, regulation, the large number of codes in force and the insufficient funds allocated to research and development.

Technological changes do not take place overnight in the construction industry; rather, acceptance is achieved gradually. Frequently, these changes take the form of improved materials, equipment and production methods. Innovations in materials and equipment come from other countries and from other sectors than construction in the strict sense (e.g. : insulation, vapour barriers, piping and interior doors developed by the chemical products industry). More often, they come from the United States or Europe, but are adapted to Canadian market conditions by supplier-manufacturers.

Among the innovative designs in housing production, some companies have developed and marketed new techniques that appear very promising.

These companies have developed structural panel systems and their products are gradually gaining acceptance in the Québec market. We will now describe some of these systems.

2.2.1 System based on polyhedrons made of structural panels

In 1984, the company which developed this system with its own financial resources was awarded the prize for company of the year. The futuristic hexagonal design of the exterior architecture makes use of highly energy-efficient metallic walls.

Although the units produced to date are of superior quality and offer unique possibilities for installation on land where access is difficult, they have yet to gain popular favour in part because of their non-traditional appearance. Nonetheless, several units have been built throughout Québec and in resort areas.

Housing project made up of hexagon-shaped houses using factory-made panels.

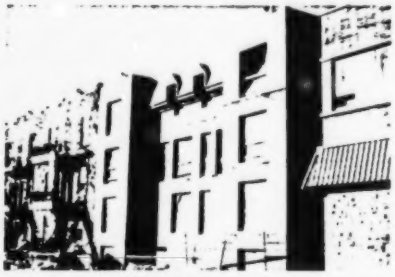
20- Economic Council of Canada. **Toward More Stable Growth in Construction**. [s.l.], ECC, 1974, p. 34.

The company is currently focusing its activities on countries where the system has been well received, in particular in France and the Antilles, where the units can be integrated particularly well into rugged or mountainous settings. This illustrates one of the advantages of technological innovations which are easier to export than traditional techniques.

2.2.2 System based on waferboard panels enclosing non-rigid insulation

A new panel system designed and developed in Québec after many years of research appears ready to establish itself in the market.

Waferboard panels enclosing a non-rigid insulation enable optimum utilization of the transport vehicle's cargo space.



Because of their flexibility from an architectural standpoint, waferboard panels can be used in high-density areas and blend in with the environment.

Waferboard panels are assembled quickly and easily.

The new technology features factory-assembled waferboard panels used as structural elements enclosing thermal insulation inside highly energy-efficient sealed panels. Users appreciate the flexibility and ease of installation of factory-made panels.

The company has improved the product following a reorganization. Its new plant uses the latest CAD techniques and its market is expanding.

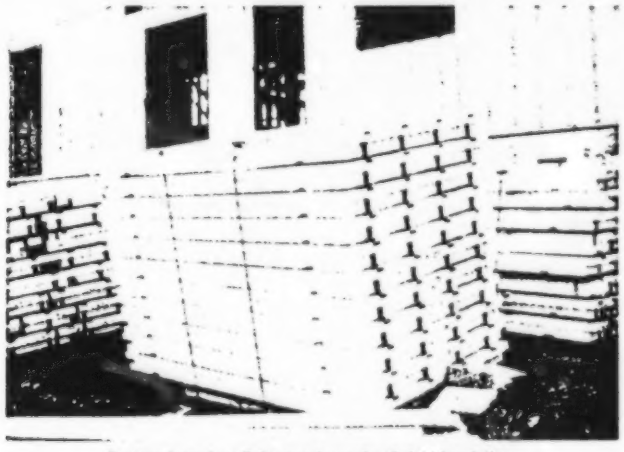
In addition to the many residential units built in the province, the system's flexibility can be applied to build apartment buildings of up to four stories. The speed of assembly generates savings compared to traditional building techniques. The system can be adapted to any architectural form, which suits buyers who are increasingly looking for a personalized house.

These panels can be shipped easily and could offer great export potential.

2.2.3 System based on panels with rigid insulation

This system was invented in Nova Scotia and introduced to Québec some years ago through the sale of franchises. It is a transfer of technology which is growing quickly in the Montréal region.

The design consists of small (4 × 8) manufactured structural panels. The panel consists of molded rigid insulation which is maintained by a structure of oven-dried wood with no exterior covering. Houses which use these panels boast great architectural flexibility. The exterior walls of a single-family house can be assembled in half a day.



System based on light panels made of rigid insulation, numbered, stacked and ready for assembly.

Judging from the increased use of such panels by contractors, it appears the system satisfies the requirements of designers, assemblers and buyers. It could become widely used in the years ahead since, like pre-fabricated rook trusses commonly used today, it helps increase the degree of on-site industrialization.

The system's flexibility allows it to be used in multi-unit structures of up to four storeys, which makes it accessible to a larger portion of the housing market. It can be easily transported, making it ideal for export purposes.

2.3 Obstacles to technical innovation

2.3.1 Fragmentation of the industry

According to a study by the Institute for Research in Construction (IRC), a technological innovation takes from 15 to 25 years to reach the market. It goes on to say that the fragmentation caused by specialization in the construction industry and poor channels of communication among its members are powerful factors hampering innovation flow.[21]

The industry is made up of a large number of very small firms, many of which are subcontractors in various specialties, which perpetuates their isolation. The lack of communication and fear of the risk involved in using new technologies or new products slow the development of new technologies.

Although buyers are the main beneficiaries of the innovations arising from this research, they are poorly informed of the benefits they stand to gain or are not in a position to invest funds in them.

Although professionals have a great deal of influence over the design of a building, the specification of a product and building techniques, they show little inclination to use new technologies since, in most cases, they must bear the risk whereas all the benefits accrue to the owner.

Other factors which slow the adoption of innovations in the production of housing include regulation, demand which is subject to seasonal variations, the economic situation which is not always favourable and the low level of research.

2.3.2 Regulation

The legislative and regulatory framework tends to prevent technological change because the prescriptive nature of codes encourages only traditional building techniques.

The rigid regulatory framework hampers the industry's ability to innovate and prevents it from using within a reasonable time the most technologically advanced concepts, systems and materials. The variety of construction regulations and the multiplicity of organizations with jurisdiction in the field of construction are additional sources of difficulties, creating a climate of confusion and additional costs for the construction industry.

These problems are common to all provinces and the federal government is currently working to develop an overall strategy to reform the regulations involving sixteen departments and seven organizations. Québec is currently participating in federal-provincial meetings which may lead to the standardization and computerization of codes and regulations, which would improve information sharing between provinces.

With a similar goal in mind, Québec gave assent to Bill 53 on June 20, 1985 which, among other things, consolidates and standardizes the numerous pieces of legislation establishing construction and safety standards. However, only the part of the legislation which created the Commission de la construction du Québec is currently in effect, while the committee studying this bill is waiting for new instructions.

21- Institute for Research in Construction. **The Construction Industry and the Issues Facing It: An Overview**. Op. cit., p. 5-6.

Any initiative that will result in improving regulatory mechanisms is desirable from the standpoint of promoting the construction industry's productivity.

2.3.3 Research and development in Québec

Currently, research and development hold the key to economic progress in every industrialized country. Canada lags significantly behind other countries in this field. According to Statistics Canada:

> **"Canada's relative industrial R & D expenditures amount to about 0.9% of domestic industrial product and are comparable to those of "medium size" OECD member countries, but significantly lower than those of countries such as the United States (2.2%), Japan (1.9%) and Sweden (2.6%)".** (translation)[22]

Québec, for its part, currently spends only 1.4% of its gross domestic product on research and technological development. In 1985, Québec's total internal R&D spending amounted to $619 million, while Ontario spent more than twice as much, $1 591 million.

Québec does not receive a fair share of federal funds allocated to R&D contracts. Ottawa is the main source of R&D funds in the construction industry in Canada and in 1986-1987, it awarded 4.6 times more funds for R&D contracts in Ontario than in Québec for the industry as a whole.[23] At the same time, the Québec government's financial effort for research and development is greater than that of Ontario.[24]

Reports also show that businessmen in Québec are more aware of the importance of research and development, but their investment in R&D is not much more than it was ten years ago.[25]

However, statistics show that 44% of business productivity gains are attributable to technological innovation[26] and there is every reason to believe that intensifying competition will increase the vulnerability of sectors of the economy which fail to make the necessary efforts. Of 20 000 patents granted in Canada last year, only about 2 000 originated within the country, of which 330 were issued to Quebecers.

The Centre de recherche industrielle du Québec (CRIQ) maintains that Québec companies wishing to break new ground will have to shift their focus increasingly towards technology transfers.[27] However, many new organizations are being set up, such as the **Groupe d'action pour l'avancement technologique et industriel de la région de Québec (GATIQ)** and the **Bureau de valorisation des applications de la recherche (BVAR)**, to help businesses link up with university research activities to jointly develop new technologies. In this vein, the National Research Council of Canada established a program two years ago to support universities wishing to promote their relations with private enterprise, whether large or small companies.

22- Statistics Canada. **Industrial research and development statistics (with estimates)**, catalogue no. 88-202, p. 7.

23- Conseil de la science et de la technologie. **Avis sur la politique des subventions de contrepartie et les universités du Québec**. Sainte-Foy, (Québec), CST, 1987.

24- Statistics Canada. Catalogue nos. 88-201, 88-202 and 88-203.

25- **Les Affaires**. "R et D : une sensibilisation de plus en plus forte". Special section on innovation and technology, November 21, 1987, p. 1-6.

26-27- **Les Affaires**. Op. cit.

26- "Le Canada accuse un sérieux retard en R et D", p. 1-3.

27- "Selon le CRIQ, les transferts de technologie sont prioritaires", p. 1-4.

In the construction sector, however, research is almost nonexistent. Construction companies are generally small and entrepreneurs rely on makers of materials to introduce new products or new techniques. The industry is highly fragmented and makers of materials themselves spend very little on research. Universities and public organizations funded by the government are generally responsible for research done in the construction sector.

2.4 The role and involvement of government in research

The Québec government, to encourage economic development and meet the challenge of technology, is committed to promoting research and development in businesses through tax measures and grants.[28]

Several government ministries and parapublic organizations working to promote research in the industrial or university sector have stepped up their activities. However, the importance of the construction industry to Québec's economy appears to be under-estimated, since little research work is being done in that field.

The following organizations have programs or are conducting studies which could be of greater benefit to the industry if some form of consultation and concerted action were in place among the players and if certain aspects were given priority.

- the Fonds pour la formation de chercheurs et l'aide à la recherche (FCAR);
- the Agence québécoise de valorisation industrielle de la recherche (AQVIR);
- the Centre de recherche industrielle du Québec (CRIQ);
- the ministère de l'Industrie, du Commerce et de la Technologie du Québec
- the Conseil de la science et de la technologie of the ministère de l'Éducation
- Concordia University's Centre for Building Studies.

2.4.1 FCAR: Fonds pour la formation de chercheurs et l'aide à la recherche[29]

The purpose of this organization is to promote and provide financial assistance for research at the university level, dissemination of knowledge in all scientific fields and training of researchers. The FCAR administers seven different programs and organizes competitions for grants open to researchers and university students, college scientific personnel and researchers affiliated with a recognized institution.

Construction-related disciplines which receive assistance from this organization include architecture and several categories of construction, materials, mechanical and electrical engineering.

According to the FCAR's annual report, it would be difficult to establish what portion of the annual budget of $32 million is allocated to research projects in construction engineering. An annual amount of $130 000 is paid to Concordia University for the operations of its Centre for Building Studies, and funding of up to $100 000 was provided during 1986-1987 to researchers in construction-related fields.

28- Notes for an address by the Prime Minister. **Les nouvelles technologies et le développement des PME**, 1987.
29- Fonds pour la formation de chercheurs et l'aide à la recherche. **Guide des subventions 1988-1989**. Québec, FCAR, 1987.

2.4.2 AQVIR: Agence québécoise de valorisation industrielle de la recherche

AQVIR is a corporation of the Québec government under the authority of the Minister of Industry, Commerce and Technology. It was formed under a bill given assent in December 1983 to promote technological innovation and to contribute to the practical commercial or industrial application of research results with potential economic spinoffs in Québec. This organization is involved in the development of innovative products with commercial potential and shares the innovator's financial risk with a "risk loan" repayable out of royalties on sales.

To date, AQVIR has made commitments of financial assistance to more than 70 projects for a total of $28 million.[30] However, there are currently no projects directly applicable to housing, illustrating this sector's absence from research.

2.4.3 CRIQ: Centre de recherche industrielle du Québec

The CRIQ is a Crown corporation whose purpose is to support and stimulate technological development in manufacturing firms.

The corporation has laboratories in Montréal and Sainte-Foy. It concentrates its activities in the fields of materials and mechanical and production engineering processes. The organization develops automation and robotics procedures, as well as computer-assisted design, manufacturing and production control systems (CAD/CAM/CAP). Its clients include lumber companies and various manufacturing concerns in the building materials sector.

Although the government must be a major partner in research and development, companies must be convinced that R&D is necessary for their growth. Small companies and often individual investors are the main sources of funds for fledgling companies in innovative areas.

Very few companies working in construction-related fields have made use of the CRIQ's services. However, the waferboard panel firm mentioned earlier had the CRIQ perform structural tests on its product. Currently, research is under way on recovering wood to make joists using glued pieces, which would be an innovative product in Québec and would eventually benefit the wood industry.

2.4.4 Concordia University (Centre for Building Studies)

Concordia University has taken an active part in the development of the construction industry with its **Centre for Building Studies** (CBS). The Centre administers the only university program in Canada with courses in building engineering up to the doctorate level. The Centre carries on a great many research projects on all aspects of building technology and does analyses of various materials.

In 1984, the Québec government designated the Centre as a "centre of excellence" for the province and provided a grant of $2.4 million to enable it to establish the Société d'informatique et de recherche pour l'industrie de la construction (SIRICON). This corporation works with the construction industry to facilitate the introduction of computers in all areas of the industry by undertaking feasibility studies and developing new software in all sectors of building engineering.

30- Turcotte, Claude. "L'AQVIR existe pour vous épauler!". **Le Devoir**. [Montréal]. August 11, 1987, p. 5.

The organization was recently chosen by the SQMH, in cooperation with the ministère de l'Industrie, du Commerce et de la Technologie and CMHC, to study the possibility of introducing computer-assisted design (CAD) systems in manufactured housing operations. Initial observations have shown that the low level of automation in the plants currently prevents these systems from being used to their full potential.

However, it does appear that the use of CAD systems by professionals in the field will become one of the most effective marketing tools in the residential construction sector.

This study and many more which are generally funded by the industry promote the transfer of knowledge accumulated by the university towards the industry and the general public, which should be encouraged even more.

③ TECHNOLOGY AND RESEARCH OUTSIDE QUÉBEC

3.1 In Canada

3.1.1 The federal government

Canada Mortgage and Housing Corporation (CMHC)

The Canada Mortgage and Housing Corporation is authorized to act on behalf of the federal government on all matters defined by housing legislation and mainly by the National Housing Act. Under the Act, CMHC assists the federal government to achieve its economic growth, job creation and energy conservation objectives.

More generally, the corporation is responsible for improving the quality of housing and urban growth through research, development and dissemination of information. It also advises the government in matters related to housing policy.[31]

Under Part V of the Act, CMHC is authorized to allocate funds for research into the socioeconomic and technical aspects of housing. Part of its research budget of more than $9 million is used to fund a program promoting residential housing technology.

Under this program, CMHC can pay up to $15 000 to a builder or anyone else who proposes innovative methods or products to increase construction or residential renovation effectiveness. For example, the waferboard panel firm mentioned earlier qualified under this program to develop its innovative design.

Although this program and others are open to all provinces equally, Québec does not take full advantage of the financial assistance available. CMHC-sponsored research contracts resulting from public calls for tenders are awarded less frequently to Québec because, in particular, of the smaller number of firms specialized in housing research. Québec still fails to maintain enough regular contacts with representatives of CMHC and of the research division in Ottawa to make up for these deficiencies.

The National Housing Research Committee, recently set up by CMHC, could become a forum for Québec to present its views in this field. It must enable the development of research in Canada to be monitored more closely, and greater cooperation with CMHC and other organizations to obtain and distribute relevant information on subjects of interest to Québec.

Institute for Research in Construction (IRC)

The Institute for Research in Construction is an agency of the National Research Council of Canada. It is the largest research centre in Canada serving the construction industry.[32] The agency has always maintained close contacts with the construction industry, allowing it to direct its research in accordance with the industry's needs.

In 1985, the NRCC formed the **Canadian Construction Research Board** (CCRB) made up of 25 members from the university, public and private sectors. Its purpose was to give the construction industry a voice in the IRC's policies and research programs. Its initial role was to identify the industry's technological needs and make the necessary recommendations to develop this technology.

31- Canada Mortgage and Housing Corporation. **Annual Report, 1986**. Ottawa, CMHC, 1987.
32- Institute for Research in Construction. **Research Program 1986-1987**. Ottawa, National Research Council of Canada, 1987.

Following a meeting in July 1986 involving senior provincial officials responsible for issues facing the Canadian construction industry, IRC prepared a document giving an up-to-date and comprehensive view of the economic, regulatory and technological concerns of the industry. This briefing document presents an overview of the issues facing one of the largest industries in the economy. It describes the results of major studies and of consultations with experts on various aspects of construction.

Among its conclusions, the study notes that the construction industry will prosper economically only if productivity increases. The study states the following factors are necessary for an increase in productivity:

- **improved communications among highly specialized construction companies;**
- **better utilization of labour;**
- **improved technology transfers; and**
- **regulatory reform.**

The study also notes that:
innovation in the construction industry is the most clearly identifiable key to increased international market share.[33]

High-technology products are the ones which sell abroad because, in many cases, traditional products produced with less highly developed technology are already available in the target markets.

In accordance with its mandate, the IRC has established the **Construction Technological Service** which acts as a liaison with the industry for publications, consultations on technical problems, research contracts and requests for technical testing. Recently, it has become involved in establishing, along with private organizations, **Canadian Construction Information Services** (CCIS) which, using a state of the art system, will provide virtually all types of information on construction. The system will give users access to government data banks, available information on construction products, research and development, innovative and tested methods and processes, along with building codes and cost data.

This complex information system will incorporate other features making it a unique source of data, offering substantial benefits to future users.

In addition, since April 1, 1988, the IRC administers the new **Canadian Construction Materials Centre** which will provide, for the first time in Canada, nationally recognized evaluations of all categories of building materials. The provinces, which have jurisdiction over approval of building materials in Canada, will play a major role in setting the operational policies of the service, acting through a special committee.

The Institute is made up of about one hundred researchers, architects and engineers. It provides services on the performance and assessment of materials, design of the building's shell, behaviour of structures, protection against fire and other areas related to construction.

Information from the Institute's management indicates that Québec, unlike Ontario, currently has no governmental link in research and technology in regard to the construction industry. The Institute mentions that this could delay technological development in this field which is very important to Québec's economy, while at the same time preventing closer relations for research with various levels of government.

33- Institute for Research in Construction. **The Construction Industry and the Issues Facing It: An Overview**. Op. cit., p. 9.

The acknowledgment of this situation indicates Québec's unfavourable position in regard to cooperation mechanisms with the IRC.

There is an urgent need to explore the options open to the Québec government to establish permanent cooperation agreements with federal organizations for research in the development of the construction industry.

3.1.2 Ontario

Ontario's Ministry of Housing has recognized that the construction industry is one of the largest and most important in the province, with expenditures of $12.9 billion in 1985. The Ministry estimated that in 1984, this industry provided the provincial treasury with revenue of $1 billion directly or indirectly.

Following a significant downturn in activity in the late 1970 s, Ontario's construction industry recovered in the mid-1980s. However, as in Québec, activity is expected to slow down in the residential, commercial and industrial sectors.

Finally, since Ontario is aware of this situation and because the industry is highly fragmented, subject to a multiplicity of regulations and productivity is low, the province has developed a strategy to revitalize the construction industry.

The **Building Industry Strategy Board** was formed following intensive consultations with representatives from the industry, labour, the university community and government. The Board obtained approval from the provincial Cabinet which granted it $14.6 million over three years to achieve its objectives.

The Board has adopted a strategy to achieve the following objectives:

- rationalize laws and regulations;
- promote development of the export market;
- increase productivity and cooperation in the industry;
- establish an international-calibre building centre.[34]

Fourteen programs have been started covering education and training, an innovative process for reforming building regulations, implementation of a process for computerizing codes, a feasibility study for the creation of a building centre, an exhibition and major industry conference, and a visit by a trade delegation to China and other Pacific Rim countries.

The brochure published by the Board notes that the strategy could produce the following benefits:

- **a 10% increase in exports of construction products would generate 7 700 jobs and an inflow of $390 million into Ontario's economy;**
- **an equivalent reduction in imports of construction products would generate 8 000 jobs and additional sales of $200 million for companies in the province;**
- **a revision of the regulations could save the three levels of government an annual total of $40 million.[35]**

34- Ontario Ministry of Housing. **A Strategy for the Building Industry**. Toronto, Ministry of Housing, [n.d.].
35- Ontario Ministry of Housing. Op. cit.

All the Commission's activities are undertaken with the cooperation of seven ministries, municipal governments, the federal government and a multitude of associations and organizations which have an interest in developing this sector of the economy.

Ontario's Ministry of Housing has entered into agreements with the Canadian Construction Research Board, the National Research Council and the Institute for Research in Construction to establish a construction information system which could eventually be used by the Building Centre.

A consulting firm has been retained to carry out the feasibility study leading to the foundation in Ontario of an international-calibre Building Centre. The study will be made public during the year.

According to the Strategy Board, this Centre would promote the industry on a permanent basis, both domestically and internationally, and would provide a wide range of services. These services would include sophisticated information sources on international building specifications, codes, prices, training, research, development, and materials testing centres. The centre could also include employer and labour associations, financial institutions, government organizations and any other group related to the construction industry.

The Board's first annual report makes clear that Ontario has already taken a significant lead over Québec in terms of regulatory reform, computerization of the code, staff training, in staging several exhibitions and conferences and in conducting several major studies.[36]

The situation in Québec resembles that in Ontario, particularly in regard to the threat from national and international competition. This should be an incentive for us to continue our investigations and initiatives to improve our knowledge of the situation of the construction industry and more specifically the housing situation as a whole.

3.1.3 Alberta

As was the case in every other province, the recession caused housing starts to drop in Alberta. They fell from 38 000 in 1981 to 16 500 in 1983. This downturn in the construction industry together with other economic considerations led the Alberta Ministry of Housing to alter its administrative structures to maintain effective delivery of public programs while holding public sector costs at their lowest level.

In this difficult situation, the Ministry of Municipal Affairs, which wants to ensure the long-term viability and competitiveness of the housing industry, administers an **Innovative Housing Grants Program**. The program provides financial assistance to the housing industry, professionals, organizations and individuals and encourages research and development.

The purpose of the assistance is to:

- achieve lower construction costs;
- improve the quality of housing;
- improve the productivity of the construction industry.[37]

36- Building Industry Strategy Board. **Report on Activities: April 1986 /April 1987**. Toronto, Ontario Ministry of Housing, 1987.
37- Alberta Municipal Affairs. **Innovative Housing Grants Program**. [n.l., n.d.]

The grants vary from $25 000 to $50 000. Priority is given to building design, building technologies, energy conservation, urban planning, development of or improvement in residential building materials, and computer technology related to residential construction.

This research and innovation incentive program has given rise to several studies which have benefited the residential construction industry.

The process of dissemination of information, research and studies under the program is highly efficient. It can provide the most recent documentation on innovative technologies developed in Canada and other countries.

In view of the weaknesses in the field of research, an equivalent program should be mounted in Québec to provide similar benefits for the construction industry and Québec's economy.

3.2 Outside Canada

3.2.1 United States: government involvement and free trade

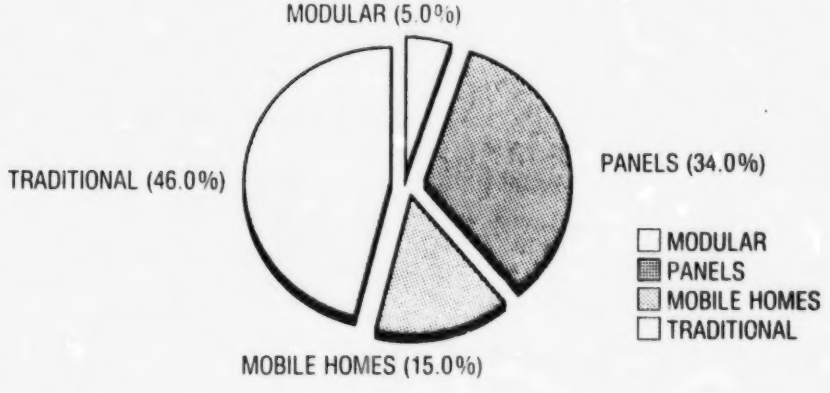
The tradition of individual home-ownership is very strong in the United States and government programs and policies have helped strengthen this tradition.

After the second world war, housing construction grew very quickly to satisfy the demand by new households which stood at 1.7 million in the 1970s. The energy crisis and the recession had a significant impact on the demand for **affordable** housing.

It was difficult for the conventional building industry to meet this challenge without technological innovations that could help to improve its productivity.

Manufactured houses are in the best position to satisfy the market for housing at an affordable price. This market currently accounts for 54% of housing construction in the United States (see Figure 8). In 1987, of 1.92 million housing starts, over one million were manufactured, and this portion of the market is growing each year.[38]

Figure 8
Composition of Housing Market in the United States in 1987
by Construction Technology



Source: **Automation in Housing & Manufactured Home Dealer**, March 1988, p. 37.

38- **Automation in Housing & Manufactured Home Dealer**. "Producers Report 3% Housing Decline in 1987", January 1988, p. 10.

The government's national urban policy report announced a major shift in direction by placing the emphasis on lower costs rather than on supply and quality. Manufactured housing was a crucial component in this new policy. Statistics provided by the Manufactured Housing Institute show these houses account for more than 75% of new houses built for families earning less than US $25 000 a year.[39]

A major study financed by CMHC states that:

> **"It has been increasingly recognized by consumers, the housing industry and government agencies, that manufactured housing, particularly mobile and modular homes, can be afforded by families who would otherwise have to depend on sub-standard accommodation or large government subsidies".[40]**

Panelized construction systems are very widespread in the United States, accounting for 34% of total new housing construction.
Source: **Automation in Housing & Manufactured Home Dealer**, June 1987, p. 14.

A top of the line panelized house, manufactured in the United States.
Source: **Automation in Housing & Manufactured Home Dealer**, April 1988 p. 16 and cover.

39- Office of Technology Assessment. Op. cit.
40- Bairstow & Associates Consulting Ltd. **Opportunities for Manufactured Housing in Canada**. Ottawa, Canada Mortgage and Housing Corporation, November 1985, p. 10.

The government and industry in the United States have taken measures to improve design, quality, choice and availability of financing for manufactured housing. In 1987, 63% of manufactured housing output consisted of panelized units (similar to systems used in Sweden), 28% of HUD-certified mobile homes and 5% of modular homes (the system most widely used in Québec), for a total of 1 040 580 units.[41]

One reason for the success of manufactured housing in the United States is its more favourable reception by the general public. Higher demand has prompted many states and municipalities to eliminate discriminatory zoning by-laws and overcome prejudice which prevented construction of prefabricated homes in many residential sectors.

More than 185 firms, spread over 410 plants, build prefabricated houses using wood frames. Up to now, U.S. manufacturers have made limited use of automation or advanced technologies. They prefer conventional production methods requiring semi-skilled low-cost labour. The use of semi-skilled labour and low production volumes are probably the two main reasons discouraging investment in high technology in the United States.

However, many large manufacturers are now exploring the potential of Japanese and Swedish technologies.

Consortia of American and foreign manufactured home builders are operating in Texas, Florida, Massachusetts, Maine, New York, Rhode Island, Michigan, Minnesota and Wisconsin. Japan and the Scandinavian countries are the main players in this market.

Compared to U.S. standards, many foreign firms are large and effective producers of manufactured housing. They have access to extensive research networks with many engineers having broad experience in mass production. More specifically, Japanese and Swedish companies make use of automated factories and receive government assistance for research. Sweden, with a population 29 times smaller than the United States, spends three times more on building research ($9 million).

However, the United States is becoming more aware of the real threat from the competition. Recently, a major study carried out by the **Office of Technology Assessment**[42] for the U.S. Congress stated that factory production of housing units would enable improved utilization of advanced automation methods and that a wide variety of technologies was currently available to increase the comfort of homes while reducing their energy consumption. The quality and cost of manufactured houses as well as the number of jobs created would be influenced by U.S. housing policies to the extent they encourage the use of new technology.

Current United States housing policy is fragmented and lacks central coordination. This situation works against the new needs of the construction industry. Several housing experts are urging that the United States government play a more active role in promoting basic research into building to protect their industry from foreign competition.

A more aggressive policy in these areas would make the United States a formidable competitor, given the production volume and economies of scale which would flow from massive utilization of technologies in use in other countries.

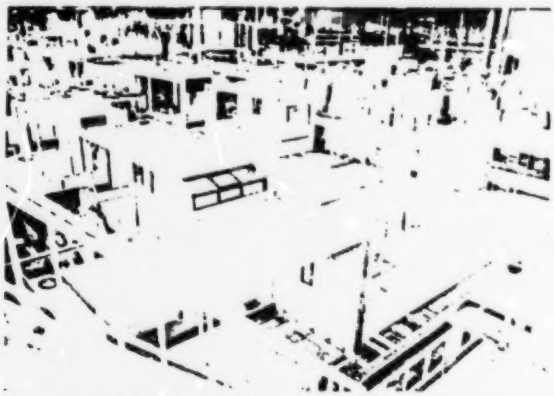
In view of the reality of free trade, builders in Québec will be faced with organized competition which will intensify over the coming years as demand in the housing market declines.

41- **Automation in Housing & Manufactured Home Dealer**. Op. cit., p. 10.
42- Office of Technology Assessment. Op. cit.

3.2.2 Japan: automation and research

Japan has a highly developed panel construction technology and cubicle method in terms of production and assembly.

Large manufactured housing plants have adapted building methods used in the automobile industry. Computer-assisted design and automated production can produce a house in record time (for instance, the Sekisui assembly line can turn out one house every 44 minutes).



An automated assembly line in a Sekisui plant, Japan
Source: **Automation in Housing & Manufactured Home Dealer**, June 1986, p. 11.

Steel is used extensively in residential construction because of very strict fire regulations and frequent earthquakes. However, wood and concrete are also widely used.

Five large companies account for 80.5% of the manufactured housing market: Misawa, Sekisui, Daiwa, National House and Sekisui Chemical. Overall, 53% of their output consists of single-family units, 32% of two-storey apartments, and 15% of apartment buildings.

These companies employ a large work force. For instance, National House employs 2 100 people, including 200 architects and 600 labourers. It produces an average of 700 units a month in each of its plants. Daiwa employs 5 670 people in 20 plants throughout the country. Misawa, the largest manufacturer of prefabricated houses in the world, produced over 22 000 single-family homes in 1985.

The flexibility of the panelized construction system gives the buyer more choice. For instance, each of Misawa's three basic models can accommodate 300 finishing options and 400 different panel dimensions. In addition to flexibility of design, Japanese manufactured houses boast other advantages over traditional houses:

- comparable or superior quality checked at the plant and guaranteed by the manufacturer;
- lower purchase price;
- less time required for construction;
- long-distance transportation (attractive for export).

The large companies have channelled significant resources into research. For instance, Misawa has set up a research centre in which it reinvests 1.5% of its sales revenue. Other companies allocate up to 2% of their budget to research.

The houses are tested in huge laboratories equipped with very sophisticated instruments. A variety of research activity is carried out. Mitsui and Mitsubishi, two of the five large construction companies, have intensified their research into North American 2x4 technology, which is becoming increasingly popular. Makers of 2x4s have formed an association and decided to bolster their credibility by providing a guarantee to new home buyers.[43] Daiwa uses panels with an exterior covering of asbestos-cement. This should interest Québec's asbestos industry, which is looking for new markets. Very strict fire standards led Daiwa to opt for a material with acknowledged fire resistant properties.

A top of the line Japanese house manufactured by the Daiwa company.

Although the social context in Japan is different from ours, that country must also deal with an aging population (an estimated 23.5% of the total population in 2021). Daiwa has worked on this problem for many years and in 1959 began manufacturing the «Mizet», a small housing unit that could be added to an existing house.

Japanese home builders are constantly innovating. Mitsubishi and National House (which operate in Canada and the United States under the name Panasonic) equip their houses with computerized control systems. These systems are now available in Canada at affordable prices.

Multidisciplinary research teams are involved. At Daiwa, for instance, the research team includes a medical expert and introduced the concept of a health house which would facilitate the growth and development of the family and children.

The major Japanese companies are represented in foreign countries. Daiwa has four subsidiaries in the United States. It has completed large housing developments in California (Skyview) and Shanghai in the People's Republic of China. Sekisui, for its part, operates chemical plants throughout the world.

43- Nantel, Bruno. «Les garanties de maisons neuves». **Actualité immobilière**, vol. XI, no. 4, winter 1988, p. 32.

The panelized construction system offers several advantages for shipping houses. Panels are shipped in containers by ship or even by plane if a disaster strikes a region and fast action is needed. The cost of transportation is reduced all the more because cargo space is used to the maximum, unlike modular construction systems in which significant volumes of air are transported.

Many factors account for the success of the Japanese manufactured housing industry:

- **extensive use of steel** which is inexpensive and complies with fire and earthquake standards;
- **population density** which results in 90% of sales being made in urban areas and shipping distances of 200-250 km at most;
- **the structure of the business community and the banking system** which offers preferred rates to entrepreneurs and access to significant amounts of capital;
- **the sub-contracting system**;
- **adaptation of houses to users' tastes** thanks to a very flexible construction system;
- **the good relations between the government and home builders**;
- **government support to the industry for the creation**;
  — of a **building centre** which emphasizes research and development and is a focal point of government, private industry and the education community;
  — of a **five-year housing construction program** which provided market stability from 1975 to 1980.

To summarize, the close cooperation between the various players involved in residential construction has resulted in the development of a highly effective technology in terms of production, adaptability and transportation.

The favourable research climate has produced positive results for builders whose companies become more profitable, and to Japanese households, which can buy high-quality houses more cheaply.

Although Japan's manufactured housing market is larger than ours in absolute terms, it accounts for the same proportion of total housing starts as Canada's, i.e. 15%. In addition, Daiwa executives say they can operate a plan at a relatively low production volume (70 to 75 houses per month) and remain economically viable.

Japan's strong international trade position together with its clear technological superiority make the North American market vulnerable to exports of Japanese products. **With major Japanese builders already active on this continent, the possibility of a Japanese conquest of our market cannot be dismissed**, particularly since this market is divided among a multitude of small local contractors continuing to follow traditional methods which change very slowly.

3.2.3 Sweden: exports and unmatched technology

In Sweden, manufactured housing covers almost all houses built in the country, namely over 90% of all housing starts. In 1983, 89% of single and semi-detached units and 92% of multi-family units were factory-made.[44]

44- Bairstow & Associates Consulting Ltd. Op. cit., p. 15.

The major companies encompass all stages of production, from cutting trees to final assembly on the site. Use of computer-assisted design (CAD) and computer-assisted manufacturing (CAM) techniques is widespread. **Many companies have developed integrated CAD/CAM systems, making Swedish technology more advanced than Japan's.**

Sweden, like the rest of Scandinavia, uses three building systems:

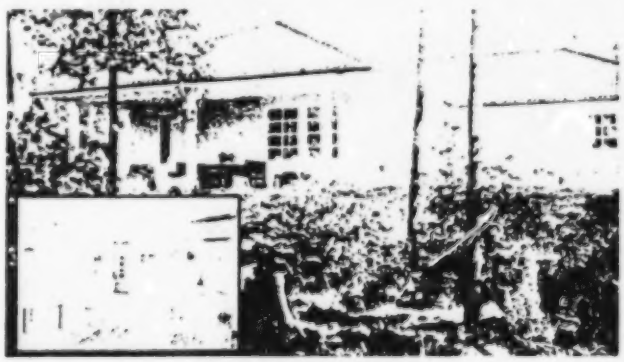
- a modular system;
- a system based on small panels (4'x8' or 1.22 x2.44m);
- a system based on large wall-size panels.

The panel system uses wood uprights exclusively. The small panels can be installed by three people (a carpenter, a plumber and an electrician). Minor changes can be made during assembly.

The most popular system is the one based on large panels. It includes doors, windows, exterior finish, insulation, vapour barrier and the interior gypsum or other finish. **These building methods produce savings of 25% to 40% on the cost of houses built using traditional building techniques.**

Swedish manufactured housing is recognized as the most energy efficient in the world. The houses provide excellent climate control thanks to air exchangers and heat pumps. Their insulation exceeds the most exacting standards in Canada, R40 for ceilings and R30 for walls and floors. In Sweden's northern regions, this is increased to R60 for ceilings and R40 for walls and floors.

In 1985, it was possible to heat a house for $150 a year, even in northern Sweden. Furthermore, all manufacturers must provide the same 10-year guarantee, regardless if the house changes hands. For comparison, Québec's Civil Code only requires a five-year guarantee; if the defect becomes apparent only gradually, it stipulates an additional five years.

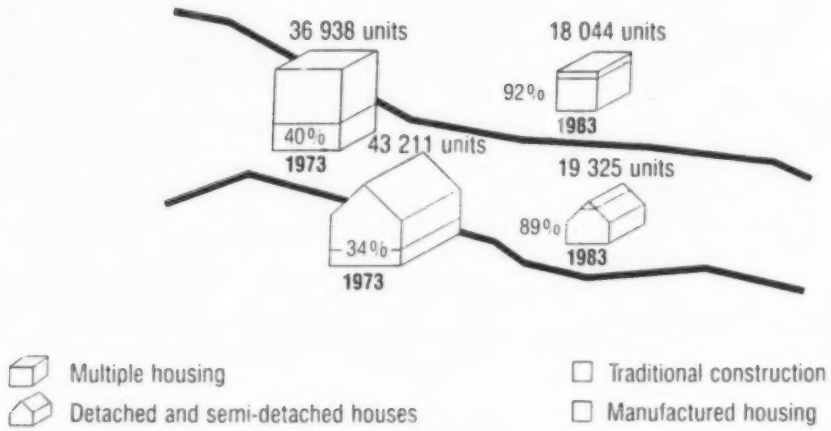


A Swedish manufactured house.
Source: **Automation in Housing & Manufactured Home Dealer**, June 1986, p. 12.

For several years, Sweden has also been dealing with declining population growth. The number of housing starts has fallen drastically, from **80 149** in 1973 to **37 369** in 1983 , a drop of 53.4% in 10 years (see Figure 9). During this period, Swedish home manufacturers increased their volume on the domestic market by 14%, and exported part of their output to markets in Western Europe, Arab countries, the Third World and, more recently, to the United States.[45]

45- Bairstow & Associates Consulting Ltd. Op. cit., p. 15.

Figure 9
Size and Composition of Housing Market in Sweden, 1973 to 1983



Source: **Opportunities for Manufactured Housing in Canada**, CMHC, 1985.

In the United States, the **Begus Inter** consortium was formed by three Swedish home manufacturers to exploit the American market. Panels made in Sweden are shipped to Boston, transported to the site and then assembled under the supervision of a technical team.

A minimum order of ten units is required, otherwise the cost of transportation becomes prohibitive. In 1985, the cost of imported houses varied from $60 000 to $300 000. U.S. promoters associated with Begus Inter maintain they have realized savings of from 60% to 65% over the cost of construction assembly on-site. Begus Inter employs U.S. architectural firms to design houses.

Another reason for the success of Swedish manufactured houses in the United States is that the product corresponds to the American way of life. The floor plan is open and the kitchen is smaller than in Swedish houses. The architects added a dining room, a two-car garage and a front porch.

Encouraged by this success, Begus Inter plans to build a plant in the United States to reduce shipping costs and, in the long run, to cover the entire country.[46] Residential developments have already been built in Massachusetts, Rhode Island, New York, New Hampshire and Vermont, where existing projects total several hundred units.

46- **Swedish News**, "Building on Experience", [n.l., n.d.]

Whereas in 1982 comment focused on the "Swedish invasion"[47], more recent newspaper coverage has emphasized American participation in the consortium's projects, on adaptation to American conditions and on the many benefits available to the buyer to attract public attention.

Taking into consideration:

- **the effectiveness of Swedish technology in manufacturing highly energy efficient houses;**
- **the use of wood as building material;**
- **the activity of Swedish companies in states bordering Québec;**
- **the recent free-trade agreement with the United States,**

we expect Québec home builders could soon be face with competition from Swedish builders with an exclusive licence in the United States.

The Swedish experience shows that a company using new technology need not achieve high production volume to be profitable. In 1983, 105 manufacturers produced an annual average of 250 single-family homes and 140 multiple units.

Swedish companies have also made use of the latest technology to penetrate markets that are much larger than their own, in regions where local builders could not really compete. Problems related to the shrinking domestic market were resolved in part by exporting a significant portion of their output. The Swedish industry was thus able to limit job losses and maintain the large revenue generated by the construction industry.

3.3 The situation in Québec

Socio-demographic data indicate that activity in the residential construction industry in Québec will fall over the coming years. **On the one hand, the decline in the number of new households and their smaller size will have an impact on the housing market, gradually and permanently reducing the number of housing starts. On the other hand, the fragmentation of existing households and the aging population will lead to a greater variety of housing needs.**

These trends assume the continuation of the current favourable economic situation, which is very uncertain in the short and long term, given the economy's cyclical fluctuations. A slowdown in construction activity together with skyrocketing interest rates or an unreasonable increase in property taxes, for instance, would exacerbate the precarious housing industry situation and have repercussions on Québec's economy as a whole.

International competition and Québec's slowness to adopt new technology in the residential construction sector also threaten the industry's stability.

Japan, whose economic health depends on its trade relations with other countries, has developed a highly effective technology in terms of production, based on the automobile industry model. Swedish technology, the most energy efficient in the world, has been developed in a country with striking similarities to Québec: a northern climate, population base, proximity to huge markets (EEC, USSR), use of wood for residential construction, slower demographic growth and an aging population. Over the past ten years, the number of housing starts has dropped drastically; manufacturers have offset some of these losses by using the latest technology. This has allowed Sweden to increase domestic demand and export a significant share of its production to foreign markets.

47- Yudis, A.J. "Swedish Made Homes Rising on N.E. Lots", **The Boston Globe**, [Boston], [n.d.].

The Swedish government has almost doubled its research and development effort. Sweden ranks first among industrialized countries in terms of industrial R&D as a percentage of gross domestic product. In the building sector alone, the research and development budget is three times more than in the United States, about $200 million.[48]

The residential construction scene in the United States is undergoing a complete overhaul. Manufactured housing accounts for a growing proportion of the market and is now responsible for more than half of all housing units produced. The U.S. government has worked to expand the use of factory production techniques by promoting the manufacture of lower-cost housing units. These policies stimulate the market and lift some of the burden from social housing programs, since some lower-income households can now become homeowners.

With free trade between Canada and the United States a reality, the presence of Japanese and Swedish firms south of the border means competition from foreign firms in our domestic market will become more intense sooner rather than later. In addition, the Swedish-American consortium Begus-Inter, which holds exclusive rights to sell Swedish houses in the United States, is especially active in states bordering Québec. The threat to Québec manufacturers of competition from foreign firms must not be under-estimated since they have the technology to compete effectively in these markets. **An export strategy based solely on the relative weakness of the Canadian dollar cannot ensure the long-term success of Québec firms in foreign markets, particularly the United States**.

Other countries invest much more public and private funds into research and development of new processes, systems and materials than Canada does. **It is abnormal that the construction sector, which accounts for 14% of GDP, receives only 0.1% to 0.2% of annual construction expenditures compared to 1.5% for other activity sectors, an average of ten times more**.[49-50] And yet such investments are in the interest of the construction industry and its workers by promoting the growth of companies. Finally, they benefit households which spend less for a higher-quality product.

Although research organizations are more active, their projects virtually ignore the housing field. The FCAR has awarded few grants to groups doing research in the field. The CRIQ provides technical assistance to companies which request it, while to date the AQVIR has not provided funds to any project related to building industry. **The incentives these organizations offer are not attractive enough for research groups, companies and individuals to turn their attention to housing problems**.

Not only is Canada's building industry behind in terms of technology compared to other industrialized countries, but also in terms of mechanisms for concerted action. Many countries have established building centres which provide various services to builders, researchers and the general public. These centres provide a focus at which the public, private and university sectors meet to pool their efforts with a view to helping the building industry to grow and finding solutions to the problems facing it.

It should be noted that a university group, with the support of an economic development organization, will soon undertake a feasibility study for the creation of a national building centre in Montréal. This centre will play a primary role in gathering and disseminating technological information and in technology transfer to the building industry. The group has indicated it intends to obtain cooperation and financial participation from the public and private sectors.

48- Office of Technology Assessment. Op. cit., p. 46.

49- Canadian Construction Research Board. **A Mandate for Technological Support to the Construction Industry**. Ottawa, National Research Council of Canada, [n.d.].

50- Institute for Research in Construction. **The Construction Industry and the Issues Facing It: An Overview**. Op. cit.

The Québec government should support this initiative, in view of Ontario's substantial lead in the field and the advantages this kind of centre would offer to the construction industry as a whole.

Other provinces have taken significant steps. The Ontario government has provided significant funding for a feasibility study with a view to establishing an international building centre in Toronto. **Québec's lack of action seriously increases the danger of resources based in Québec shifting to Ontario and crowning Toronto as the nerve centre of the building industry in Canada**.

The extraordinary level of activity on the housing market during the past few years has diverted attention from the major socio-demographic trends developing in Québec which will produce a lasting decline in activity in this industry. Since there is no escape for the residential construction industry from these trends nor from foreign competition, it will have no choice but to become more efficient by using new technologies. In this way, it may offset the serious effects of lower production and job losses in this important sector and help protect this essential activity for Québec's economic growth.

CONCLUSION

During the next few years, the industrialized countries will have to deal with declining activity in residential construction and the growing threat of foreign competition. To adjust to this situation, governments, the construction industry, unions and other organizations involved in the housing sector must be made aware of the new reality. To maintain an acceptable level of production, they will have to enter into a dialogue and establish some form of concerted action on problems which hinder development and transfer of new technology to the industry.

Resources allocated to housing research and development must be distributed more fairly to ensure that the residential construction industry receives a share corresponding to its contribution in terms of spending and investment in the economy. This is necessary if growth in the industry is to keep pace with other sectors.

In view of the technological catching-up that the residential construction industry faces compared to other countries, measures must be identified to encourage research into new building methods, new designs and new materials to produce housing at competitive prices.

Currently, businessmen and entrepreneurs are constantly seeking information from organizations such as CMHC, the MICT or the SQMH concerning the establishment of plants to produce housing using Swedish techniques. Such plants would make use of the latest CAD/CAM technology.

These promoters and businessmen are investigating opportunities in markets in Québec, Ontario and, in view of free trade, are also looking to the United States. A plant of this type is already operating in the Vancouver region, and the new plants planned for Ontario and Québec would be technologically even more advanced.

All these factors argue in favour of centralization of information concerning the construction industry and establishing the means for adequate dissemination to those involved in the industry. One such approach would be to form a Building Centre in Montréal, for which the private sector is preparing a feasibility study.

The governments of Québec and of Canada have a duty to promote initiatives in this field and to take the measures necessary to stimulate research and development in this important sector of the economy.

This will require greater government involvement in federal-provincial relations concerning existing programs and the establishment of Québec's specific needs for the development of its economy.

Encouraging technological development in every form is the surest way to enable the industry to maintain an acceptable volume of production and help provide better housing for the population of Québec.

ABBREVIATIONS AND ACRONYMS

APCHQ	Association provinciale des constructeurs d'habitation du Québec
AQVIR	Agence québécoise de valorisation industrielle de la recherche
BSQ	Bureau de la statistique du Québec
BVAR	Bureau de valorisation des applications de la recherche
CAD	Computer-assisted design
CAD/CAM	Integrated computer-assisted design and manufacturing system
CAM	Computer-assisted manufacturing
CAP	Computer-assisted production control
CBS	Centre for Building Studies (Centre des études sur le bâtiment)
CCIS	Canadian Construction Information Services
CCMC	Canadian Construction Materials Centre
CMHC	Canada Mortgage and Housing Corporation
CCRB	Canadian Construction Research Board
CRIQ	Centre de recherche industrielle du Québec
EEC	European Economic Community
FCAR	Fonds pour la formation de chercheurs et l'aide à la recherche
GATIQ	Groupe d'action pour l'avancement technologique et industriel de la région de Québec
HUD	Federal Department of Housing and Urban Development (U.S.)
IRC	Institute for Research in Construction
NRCC	National Research Council of Canada
R&D	Research and development
SIRICON	Société d'informatique et de recherche pour l'industrie de la construction
SQMH	Société québécoise des manufacturiers d'habitation

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